INTRODUCTION

Product Oriented Environmental Measures and Integrated Product Policy (IPP) in the European Union was the special topic chosen for the Copenhagen meeting. One day of the meeting was allocated to presentations within this subject and presentations were given by industrial companies, academia and authorities. In the following abstracts, papers or summaries covering the special topic presentations are given. A specially edited and supplemented version of the full special topic theme and discussions are planed published by an international publishing house. This publication should be available ultimo 2001/primo 2002. The abstracts presented here are grouped under the following headings: authorities, academia and industrial companies

AUTHORITIES

A CHALLENGE FOR MODERN SOCIETY: UNCOUPLING GROWTH AND POLLUTION

Steen Gade, Director-General of the Danish EPA
Strandgade 29
DK-1401 Copenhagen K
Denmark
Phone: +45 32 66 01 00
Fax: + 45 32 66 04 79
e-mail: mst@mst.dk

Abstract
Steen Gade addressed the issue of uncoupling economic growth and increased pollution. The point of departure was the European Unions efforts to integrate environmental policy and sector policies. Another important point was the study by European Environment Agency (EEA) on the state of the environment and its future development. Thus having addressed the necessity for and the political commitment to uncoupling economic growth and pollution, attention was drawn to challenges that must be overcome in order to secure a sustainable development. Knowledge, tools and principles that can be helpful include the concept of ecological space and the ideas behind a Integrated Product Policy (IPP). IPP uses a number of different elements and tools that is expected to support this goal e.g. sector integration, active involvement of relevant parties such as companies, retailers, consumers etc., market based approach, product information, lifecycle thinking just to mention a few of the more central elements.

Summary of the presentation
Decisions in Helsinki 1999
The EC Amsterdam Treaty states that environmental protection requirements must be integrated into the definition and implementation of the Community policies and activities. The aim is to promote sustainable development. In June 1998 in Cardiff the European Council initiated a process of integration. All relevant formations of the Council were encouraged to establish strategies for integrating environmental concerns and sustainable development in their respective policy areas.
Special focus sectors are transport, energy, agriculture, industry and internal market development.

In December 1999 in Helsinki, the European Council again had integration and strategies on the agenda. One major objective is improving the eco-efficiency of production and consumption in order to break the link between economic growth and adverse environmental effects. The succes of integration can be measured by the extent to which the sectors de-couple their economic activity from environmental impact.

EEA 1999
In 1999 the European Environmental Agency (EEA) made its third state of the environment report: "Environment in the European Union at the Turn of the Century" about the state of the environment in Europe after 25 years of EU environmental policies and the 5th Environmental Action Plan.
In EU only air pollution parameters have attained absolute uncoupling from GDP since 1990. To achieve sustainable development an absolute reduction in the total load on the environment is necessary with regard to pollution parameters. And relative- or absolute decoupling are key issues.

Environmental space
It is obvious that there are limits to amount of resources that can be consumed in Europe, if the Europeans are to share fairly with other parts of the world. Today approx. 20% of the world's population is responsible for approx. 80% of the resource consumption. Factors 4 and 10 have been mentioned as the orders of magnitude needed to increase eco-efficiency and decrease environmental pressure to obtain sustainable development. Environmental space is not yet an instrument in regulation, but it promotes policy and useful technical analysis related to given resources.

Sustainable development
As presented in UN's Brundtland report "Our common future" the three pillars of sustainable development are economic development, social development and environmental protection. Since the world-wide political commitment in 1992, sustainable development has been on the international political agenda, and in these years before Rio+10 in 2002 it sets national agendas in Denmarks as in many other countries.

A major challange when dealing with products and processes is to make a balanced assessment of social, economic and environmental impacts. The market plays a major role in achieving sustainability. But the market will not provide sustainability by itself; Integrated Product Policy (IPP) may well be a corner stone in getting there.

IPP and the Life Cycle approach
It is widely accepted that use of products poses a potential thread to the environment. It is also more and more accepted that the life cycle approach is required to get a full picture of all the potential problems connected to a specific product. It is not possible to use standards, rules, and legislation for each product put on the market. IPP must be a voluntary process and we have to change attitudes by putting IPP and cleaner products on the public agenda. But how do we get from attitude to action where the manufacturer not only wants to create cleaner products, but actually has the ability to do so. Many countries have put many resources into establishing methods and tools for Life Cycle Assessment. In Denmark we developed a life cycle assessment

tool known as the *EDIP* methodology, PC-tool and database, but getting these tools into everyday life of companies is a problem with no easy solutions. To provide knowledge, tools as ecolabels, environmental product declarations and databases are necessary but traditional activities for authorities. Another thing is actually influencing the market by stimulating sales of specific environmentally sound products by influencing consumers and by green public procurement. Such activities are new and challenges our public way of thinking. Nevertheless, we have to find ways to meet the challenge and find our role not as bystanders but as actors on the market.

Steen Gade, Director General, Danish EPA giving a presentation on De-coupling of growth and environmental pressure

THE DANISH PRODUCT ORIENTED ENVIRONMENTAL INITIATIVE – SCOPE AND CHALLENGES

Preben Kristensen, Head of division for Cleaner Products,
Danish Environmental Protection Agency
Strandgade 29
DK-1401 Copenhagen K
Denmark
Phone: +45 32 66 01 00
e-mail: mst@mst.dk

Introduction

The understanding of the complexity of the sources for environmental contamination and the development of methodologies for reducing the contamination has significantly increased during the last decade. Few years ago an end-of-pipe approach for reducing the contamination from point sources was one of the corner stones. Within the last 15 years cleaner technology measures has been introduced as a source oriented approach for reducing the amount and increasing the quality of the waste. Both cleaner technology and end-of-pipe methodologies have significantly improved the environmental quality of point sources. To-day we have realised that a further improvement of environmental quality necessitate a focus on all life stages of products - from cradle to grave - in addition to the end-of-pipe and clean technology approach.

An approach which focus a prioritised improvement of the environmental quality of all stages of the life cycle of products calls for new thinking not only by the industrial sector, but also by the authorities. While the end-of-pipe era was governed by traditional authority regulation and control, a holistic life cycle approach in addition call for an extended co-operation between the authorities and all stakeholders involved, as the traditional market forces need to be addressed. Of crucial importance for implementing this new approach is, 1) that the producers are producing and marketing environmentally cleaner products and are passing on credible and sufficient information regarding the environmental properties of the products to the down stream users and 2) that the down stream users request and purchase such products irrespective of the possible higher costs (and thus set priority to environmental quality in parallel to costs and use quality).

One of the central issues of the Danish government's Nature and Environmental Policy report in 1995 /1/ was the concern about the environmental impact from production, use and disposal of products. The report stated, that the serious environmental problems, global as well as local, call for the environmental protection measures provided so far to be supplemented by measures dealing with all aspects of product life-cycle. The background for this statement was, that the various measures implemented for reduction of the environmental impact - waste treatment, clean production processes, environmental audit systems, a.o. - would only reduce the environmental load to a certain degree and that there in addition was a need for addressing other stages in the life of products and to set the environmental quality of products on the agenda for both producers and consumers in line with other quality aspects.

As a follow-up of the above report, the agency issued in 1996 a document for initiating a discussion between all stakeholders on the objectives and means for an Intensified Product-oriented Environmental Initiative (a "green paper") /2/. The document set focus on the national and global environmental problems, propose overall environmental goals for such an action and

analyse the needed framework and terms for the market and for the stakeholders. In this light the document propose a number of new activities as well as a consolidation of present activities with the aim to increase the production and use of environmentally cleaner products.

In February 1998 a Product Oriented Environmental Action Plan was issued (1998-2002) /3/. The document outlines a number of initiatives for the support of an integrated product policy: Development of pragmatic tools for Life Cycle Assessments (LCA) for the design and improvement of cleaner products; systems for facilitating information flow within the chain of goods from industry to the users regarding such products (e.g. eco labels, environmental product declarations); activities for promoting green public procurement, among others by elaboration of environmental product guidelines for public purchasers; activities for promoting market co-operation amongst others by the development of stakeholders panels within certain product classes; etc. The Product Oriented Environmental Initiative, which focus all major life stages of the product, is supported by a financial support program of approx. 120 million DKK a year (2000 budget).

Also Sweden has launched a number of initiatives with the overall goal to approach a sustainable development and thus to reduce the environmental impact (including the use of resources) from products in its entire life cycle. The Swedish Government proposal for promoting a sustainable development was presented to the Parliament in may 1998 /4/. Since then Sweden has increased its activities within this area and Sweden has this spring announced, that the Integrated Product Policy will be one of the priorities during its Presidency of the EU in spring 2001

A Nordic co-operation in the area of product-oriented environmental policy under the Nordic Council of Ministers was initiated in 1996. A seminar on this issue was helt in Salsöbaden in Sweden in January 1998. The objective of the seminar was to promote a common Nordic understanding of the framework and the elements of the product-oriented environmental policy and to discuss measures for promoting this environmental policy. Based on the recommendations from this seminar a cross sectorial working group was formed under the Nordic Councill of Ministers in 1999. The objective of the group is to develop a common Nordic position on Integrated product policy (IPP) and to promote a further development. In february this year a technical study regarding the provisions for a common Nordic IPP was presented at another seminar at Salsöbaden.

In Marts 1998 EU issued a consultant report for debate on Integrated Product Policy (IPP) /5/. Based on an analysis of national and international developments in this area, elements of a possible EU-policy was proposed. The document was later discussed at an EU-workshop and in May 1999 the EU Member States gave the Commission a broad mandate to initiate the process for the elaboration of an integrated product policy in the European Union. The Commission intends to publish a Green Paper on a strategy on IPP during 2000. Sector integration is an important condition for the successful development of IPP. It is therefore important to note, that not only the Nordic countries ministry for consumer, for industry and for environment is represented in the Nordic cross sectorial group but also the EU Commissioner for Enterprise support the idea for an Integrated product policy.

Challenges for promoting an environmental product policy

An important challenge is to move the focus from fragments of the life cycle of products (eg. clean production processes, waste handling technology) to a prioritised action based on an analysis of the environmental aspects of the entire life cycle of the product: Use of raw material, emission during production and manufacture, environmental aspects of transportation and product use including the services linked to the use and finally waste handling, reuse/recycling and disposal.

Another important challenge is to facilitate credible and sufficient information of the properties and proper handling of the products to all the stakeholders involved in the product life chain. The request for proper information will lead to a placement of an extended responsibility to producers and manufactures for the environmental properties of the product.

A third challenge is to promote the creation of a market for cleaner products. The starting point may be the national market but the succes will depend on the international implementation. Although the focus most often are on private households as buyers of goods, all steps of the supply chain comprises purchasers. It is a major challenge to increase and to maintain the environmental issue as a quality parameter in parallel to traditional quality aspects and cost of the product. To maintain the focus is perhaps the most difficult issue and require that the improvement of the environmental quality is accepted to be significant by the consumers.

Finally the challenges for the authorities are to elaborate a framework for the product policy, to provide good conditions for a green market and to promote the co-operation between stakeholders and relevant authorities.

Initiatives in Denmark for supporting an intensified product-oriented environmental policy

The array of initiatives taken by the Danish EPA according to the Product oriented environmental action plan are briefly outlined below.

Development of know-how and methods

The LCA method: Environmental Design of Industrial Products (EDIP) /6,7/ is to be further developed: Improvement of the Chemical assessment methodology and the assessment of the waste aspect. An important activity will be to elaborate operational guidelines and tools for the various stakeholders. In addition to the EDIP-method a data-base has been developed covering data of interest for many industries in their LCA-work. This data-base will be further supplemented amongst others by data generated in projects financed by the Agency. Also the transfer of knowledge within this area to major stakeholders (designers, enterprises, public purchasers a.o.) are prioritised. The Agency is presently analysing the future organisational structure to provide a long term availability of up-dated operational LCA tools as well as high quality LCA data to the users.

Information systems

It is the intension of the Agency to initiate the development of information systems which is targeting the various stakeholders and taking into account the nature of the product groups.

Presently the EU-eco-label (the “flower”) and the Nordic “Swan” has been implemented, partly organized by the Danish eco-label secretariate. The eco-label is not able to cover all type of products and the need for information by all stakeholdres. The Agency is therefore presently considering other types of information systems and has taken the initiative to analyse frames for a national business to business environmental product declaration system based on the provisional ISO documents (type III) (3. Part certified system, LCA framework).

To support the green public procurement, environmental guidelines for a number of product groups are elaborated. During a 5 year period 50 product groups are to be covered by such guidelines. The guidelines are giving advises to purchasers (private or public) regarding the major environmental impact of the specific product group in a life-cycle framework and identifying the areas where producers should be able to improve the environmental quality of the product and offer such products to the purchasers.

Creating markets
One of the major challenges of the integrated product policy is to promote the development of a significant market for green products. Without a significant market the producers are not likely to initiate or to increase a production of clean products. A crowbar for the opening of the market is the public procurement. In Denmark the value of public procurement is amounting to more than 100 billion DKK a year. The use of a fraction of this sum for green goods will make a significant difference for the market and thus be a kick starter for the product policy. At the same time, the very attitude by the public will presumably influence also the attitude of private households. Since 1995 a ministerial circular has obliged governmental institutions to elaborate a policy for green procurement. Also in a number of counties and municipalities green public procurement has been organised.

In 1998 an agreement was made between the Minister of Environment and Energy and the municipalities and counties to set up a common framework for public procurement for the entire public sector. The agreement also include an objective to set up overall goals for green procurement and to develop report format and benchmark indicators for a future reporting of the progress of the green procurement in relation to those goals. Some of the initiatives in 2000 for promoting the entire public sector to increase the purchase of green goods will be focussed on 4 product areas: Electronics, furniture, textile detergents and textile cleaning services, cleaning agents and cleaning services.

The success of an integrated product policy is very much dependent of the establishment of an international market. Therefore the Danish EPA find it very important to participate actively in the development of international policies within this area. To increase and maintain an international green market, a number of aspects should be focused: The development of high environmental quality CEN product standards are important for the possibility to improve the environmental quality of products. Also the EU tender directives for public purchase should give better possibility for taking environmental considerations into account

Stakeholder co-operation
It is important that the major stakeholders are invited for a co-operation on these issues. The Agency therefore initiated a number of round-table discussions on the means and methods for an

integrated product policy. In 1998 product-panels was established for goods transportation, textiles and electronic devices and in 2000 a new panel will be formed for “buildings". The members of the panels are major stakeholders representing all important stages of the product lifecycle (producers, users, waste managers, authorities). The 3 panels formed in 1998 have elaborated action plans for promoting a green market suggesting initiatives related to the specific product areas and have taken a number of initiatives according to these plans (Workshops, information materials, development projects). The Textile panel has established an environmental information centre and is planning a campaign for green products labelled with the EU ecolabel next year. The goods transportation panel is elaborating a bench mark system and an environmental management system.

Waste management
Reducing the amount of waste generated and increasing the reuse and recycling of the waste generated is an important aspect in the Danish integrated product policy. The experiences regarding the environmental problems related to reuse/recycling and disposal are very important also for the future design of cleaner products. An action plan covering this area was issued last year (Waste 21).

Financial subsidy scheme
To support the integrated product policy a subsidy scheme of approx. 110 mill DKK a year (2000 budget) is in operation. The Environmental Council of Cleaner Products – a council with representatives from the major stakeholders (producers, consumers, environmental organisations, authorities, academia a.o.) – elaborate a yearly plan of priorities for the subsidies. The Danish Environmental Protection Agency grants specific projects within the priority plan.

References
/1/ Ministry of Environment and Energy, Denmark: Nature and Environmental Policy Report, June 1995
/2/ Danish Environmental Protection Agency: Intensified Product-oriented Environmental Action - A Green Paper. Proposal from the Danish Environmental Protection Agency. November 1996 (preliminary translated edition)
/3/ Danish Environmental Protection Agency:The Product-oriented Environmental Actions, February 1998 (in Danish)
/4/ Ministry of the Environment, Sweden: Swedish Environmental Quality Objectives, a summary of the Swedish Government’s Bill 1997/98: 145. Environmental Policy for a Sustainable Sweden June 1998
/5/ Integrated Product Policy, Final Report to the European Commission: DG XI. Ernest & Young, March 1998 (confidential)
/6/ Wenzel, H., M. Hauschild and L. Alting: Environmental Assessment of Products. Vol. 1: Methodology, tools and case studies in product development. Chapman & Hall 1997
/7/ Hauschild, M. and H. Wenzel: Environmental Assessment of Products. Vol. 2: Scientific background. Chapman & Hall 1998

ACADEMIA

THE CONCEPT OF ECO-DESIGN AND RESULTS FROM THE DUTCH ECO-DESIGN PROGRAMMES

Tom van der Horst
Sustainable Product Innovation Department
TNO, The Netherlands

Huge public programs have been undertaken in The Netherlands and a large number of products have undergone considerations of environmental improvements. Tom van der Horst has been involved from the beginning and is today Manager of Sustainable Product Innovation Department at TNO.

INDECOL - NTNU'S INDUSTRIAL ECOLOGY PROGRAMME

Annik Magerholm Fet
Department of Industrial Economy and Technology Management,
Norwegian University of Science and Technology (NTNU)

Introduction to Industrial Ecology

The transformation into a sustainable society does not only require an environmentally sound technology. Industrial ecology (IndEcol) is about designing sustainable structures - technologically, economically as well as socially and individually. There are several important elements within IndEcol; improving the metabolic pathways, creating loop-closing, dematerialising industrial output, patterns of energy use, balancing industrial input and output to natural ecosystem capacity, policy to conform with long-term industrial system evolution, and new action-co-ordinating structures, communicative linkages, and information.

Tools and methods

The future focus of environmental concerns seems to change from site specific towards the life cycle perspective. This means that the holistic perspective must be taken into consideration when an industry wants to improve its environmental performance. A company's environmental performance is not only a measure of the impacts caused by the production processes, it is also a total measure of the environmental impacts caused by the products and the activities, idealistically viewed in a life cycle perspective. The goal must be to reduce the environmental impact in every phase of the life cycle. To reach this goal, appropriate methods for evaluating and improving the environmental performance must be taken into use. A model of the levels of environmental performances is shown in figure 1. The first axis is the time axis, the product's lifetime with its phases in planning, manufacturing, use and disposal, human lifetime and the civilisation span. The second axis indicates the scope of the environmental concern, ranging from a single product life cycle, to x products within one manufacturer and towards x manufacturers and the society.

The areas in figure 1 represent environmental performance efforts at different levels; 1.Environmental Engineering, 2.Pollution Prevention, 3.Environmental Conscious Design and

Manufacturing, 4.Industrial Ecology, and 5.Sustainable Development. Environmental Engineering includes here various types of engineering and production. Pollution Prevention takes system thinking into account, and the planning process is essential. The other concepts, Environmental Conscious Design and Manufacturing are related to product design and improvement of products concerning the manufacturing process, the distribution, the use and final disposal of the products. Both Sustainable Development and Industrial Ecology are concepts for the macro (and meso) level, taking environmental, economic and social issues into consideration. Companies may find themselves within these areas. A shift or movement from one area to the next area represents a change towards more holistic thinking and focus on the life cycle performance.

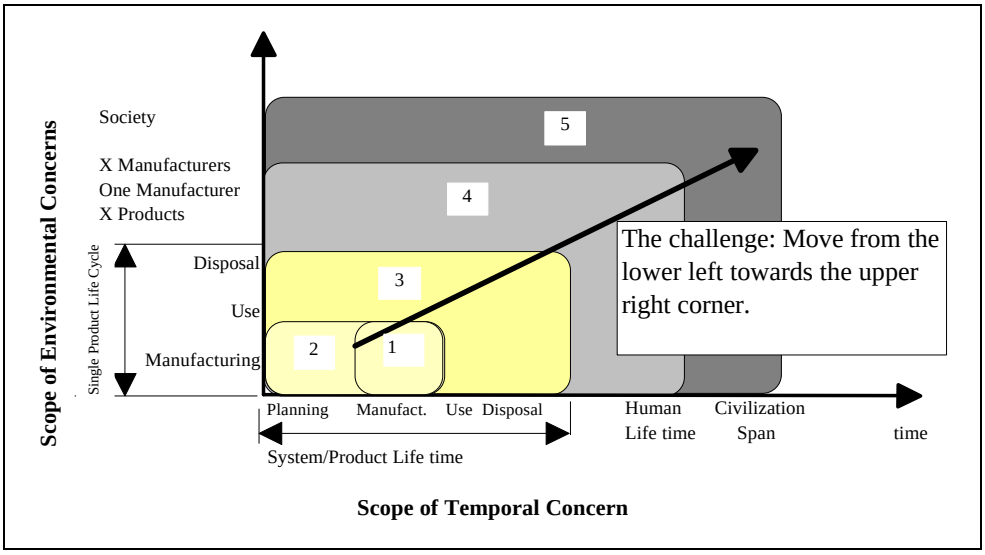


Figure1: Classification of environmental performance levels. Modified after Bras (1996).

There are different tools and methods for improving the life-cycle environmental performance. For production systems (”process oriented tools”) material flow and energy analysis, Environmental Accounting (EAc) and Cleaner Production (CP) are frequently used. These outline procedures for conducting assessments to identify opportunities for waste reduction or elimination. Further it describes how to use the results to develop pollution prevention options, recycling and recovery, and how to implement those options that withstand feasibility analyses.

For product systems Life Cycle Assessment (LCA), Life Cycle Screening (LCS), Design for Environment (DfE) and Eco-labelling are important (”product oriented tools”). The main steps in an LCA/LCS are *Goal and scope definition*, *Inventory analysis*, *Impact assessment* and *Interpretation.* According to goal and scope definition the application, depth and subject of the study, the functional unit and the system boundaries must be defined. Interpretation is the phase in which a synthesis is drawn from the findings, and they may form conclusions and recommendations to product improvements. When the intention is to identify key issues for further investigations, e.g. identify parts of a life cycle that needs further research, an LCS should be carried out. An LCS is a simplification of an LCA. Based on information drawn from LCA /

LCS, the traditional list of product design criteria should be supplemented with environmental conscious design requirements. Eco-labels are used to provide information about the environmental impact of a product.

Companies that adopt CP, LCA, DfE etc., normally improve their overall environmental performance because of better housekeeping and better products. To achieve continuous improvement, their management systems should build on principles of environmental consciousness. Formal Environmental Management Systems (EMS), Environmental Auditing (EA), or Environmental Performance Evaluation (EPE) in accordance to given standards, help companies in this work. Environmental management systems and environmental regulations are of great importance both for organisational and societal systems.

The presented methods are systematised into a framework similar to the one shown in figure 2. Area 1 is related to manufacturing processes, and appropriate tools are CP (in the narrow sense) and EAc. The next area is related to products and their life cycles. Appropriate tools are LCS, LCA, and DfE for the purpose of environmental conscious product development. Area 3 represents one company, EMS, EA and EPE are important here. At society and global system level, policy programs and international regulations are drawing up the guidelines for how to improve environmental performance in a broader term perspective.

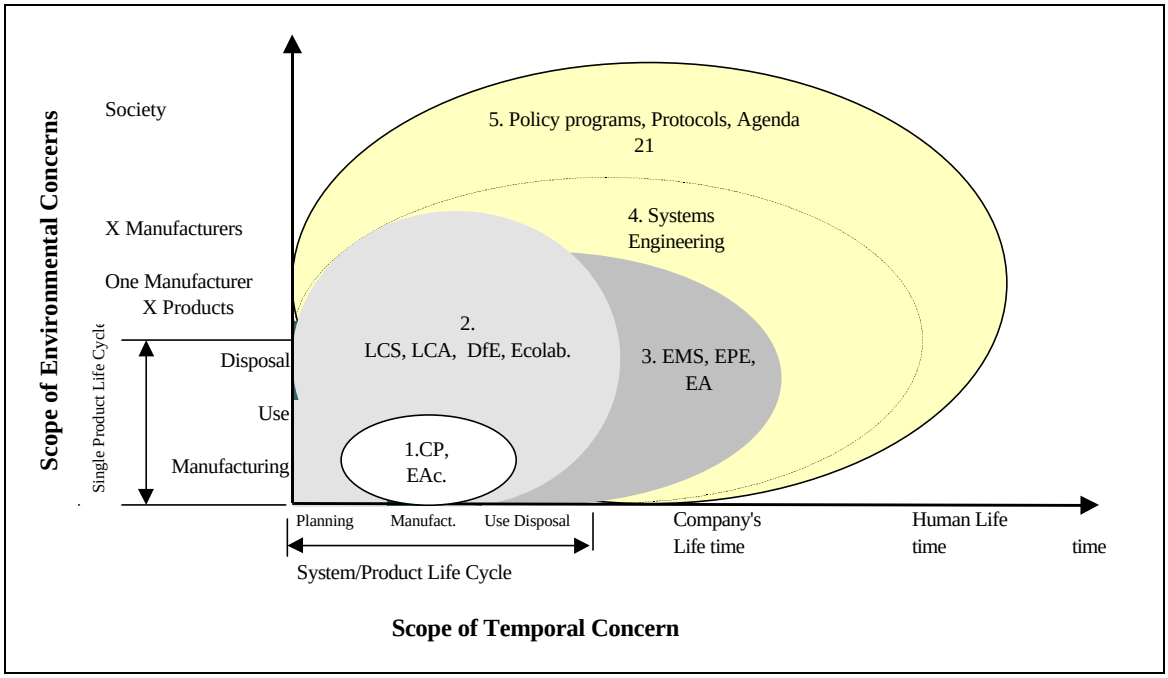


Figure 2: A classification of methods and tools for environmental performance improvements.

Study programme
An interdisciplinary study programme on IndEcol is established at NTNU. The intention of this programme is to create an academic basis for IndEcol in close collaboration with our partners in industry and government administration. Our activities are organised around three main focus areas: *Education, research, and outreach activities.* The study programme has ten courses, all with a focus to industrial ecology principles, see Table 1.

In addition we are also involved in a few other courses where we make use of distance learning courses delivered over the internet. The study programme has a horizontal organisation, and works across the structure of five faculties; the faculties of Civil and Environmental Engineering (the host faculty); of Mechanical Engineering; of Chemistry and Biology; of Social Sciences and Technology Management and of History and Philosophy. The organisation of IndEcol is shown in figure 3.

Table: Courses in the IndEcol study programme 1999 - 2001

Environment and resource economy	Fall 1999
Environmental Science Environment & Safety Introduction to Industrial Ecology	Spring 2000
LCA - Methodology & Application Environmental Politics Energy and Industrial Ecology Geo-Resources Ecotoxicology and Environmental Resources	Fall 2000
Material Loop Closing Interdisciplinary Project 1	Spring 2001
Interdisciplinary Project 2	Fall 2001

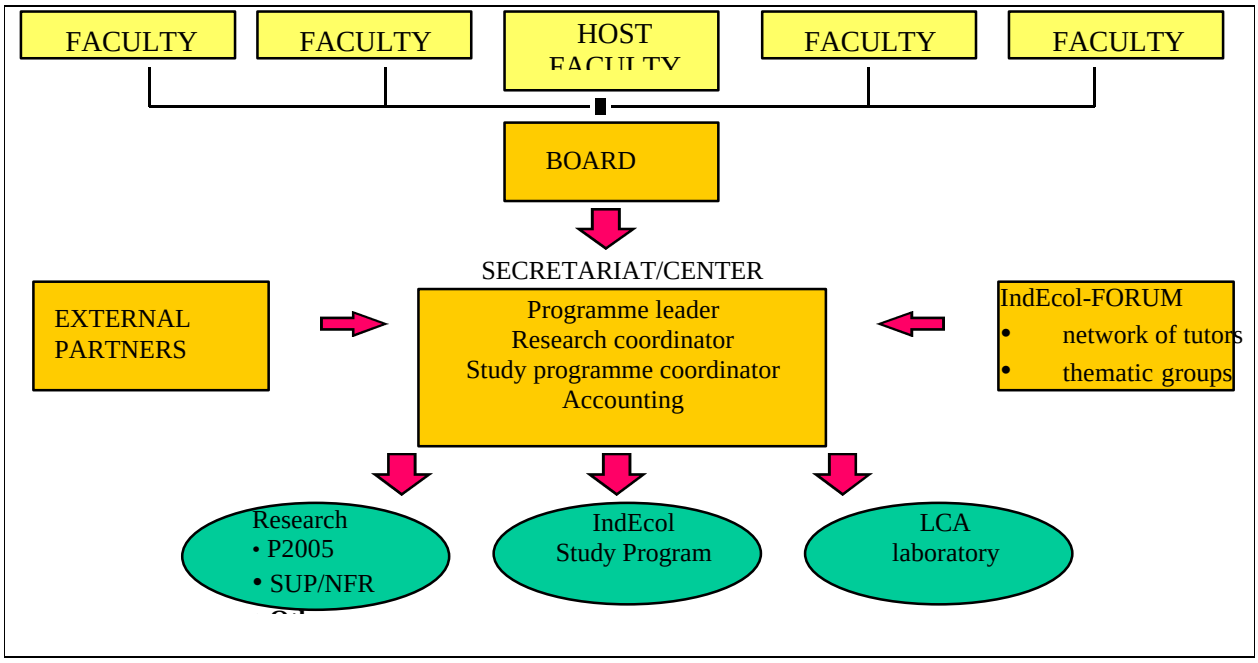


Figure 3: Organisation of IndEcol.

Research programme

Closely related to the study program there is a research programme called Productivity[1] 2005. The main objective is to increase know-how and knowledge in alliances between Norwegian manufacturing industry and NTNU/Sintef. It aims at high international level of strategic competence within technology, organisation and management. Main projects are Integrated product development (IPU), Companies in networks (BiN), Industrial Ecology (IndEcol), and Flexible, effective, reliable production (FEPP) . Our project "P2005 Industrial ecology" is one of the key focus areas in P2005, and gives us a long-term financial basis for the development of theory and methodology in the area of IndEcol. The strategy of research activities at IndEcol is to focus on collaboration in a multidisciplinary setting, but with an emphasis to issues that we believe have potentials for advancing the area of IndEcol within our university. We want to give a high priority to research projects at the PhD and Post-doctoral level, as well as students' research projects at the graduate level. Objectives of P2005 Industrial ecology are to raise the level of expertise at NTNU, and disseminate knowledge on *product, production and recycling systems*, through research and networking in such a way that the Norwegian manufacturing industry has access to candidates, expertise and methodology that will help companies implement more eco-effective and competitive solutions in such systems.

[1] Research program supported by Norway's Research Council, 1998-2005.

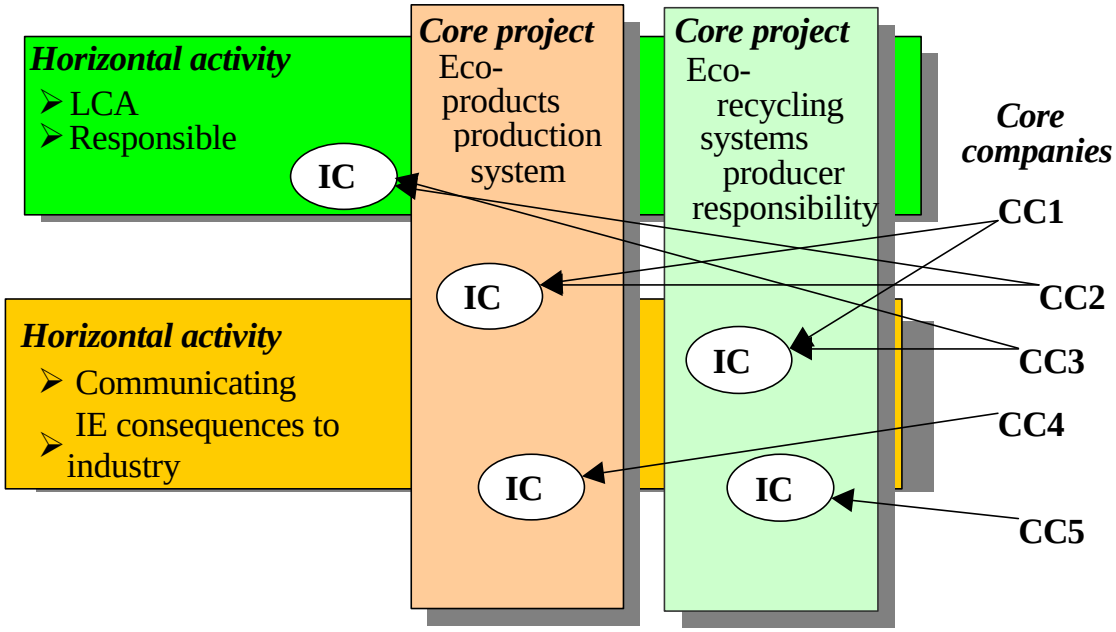


Figure 4: P2005 IndEcol structure

The P2005 IndEcol is structured in two core projecst. The first one is *Eco-effective products and production systems* with the research activities undertaken within two main research strategies: *Eco-effective value chain management in industry* and *Factor X development of technical systems* Both activities are directly connected to industrial cases. Three general research subjects will be covered with reference to each of the research strategies: 1) Methodologies for quantification of eco-effectiveness with regard to products, companies and networks of companies, and how to use this information in specific industrial cases. 2) Governmental regulations and financial instruments as promoters or barriers to development of eco-effective solutions in product and production systems, and 3) Organisational learning and new ways of managing eco-effective companies and networks of companies in relation to product and production development.

The second core project is *Eco-effective recycling systems and producer responsibility.* The research activities hereunder will be carried out within the main research strategies *Evaluation of eco-effectiveness in recycling systems* and *Principles of good practice in local and national recycling systems.* They will cover the same strategies as mentioned above.

One central activity in the IndEcol program is the LCA-laboratory. This will help students and persons employed at NTNU to get a more holistic view of the challenges we are facing. This research is to be carried out in accordance with the same principles used in the vertical core projects.

P2005 IndEcol Industrial case-projects in 1999 – 2000 are:

- Eco-effective value chains in the food industry
- Environmental Indicators and accounting methods in furniture production systems

- From eco-design to factor 4/10 development in eco-effectiveness
- Eco-efficiency of beverage container recycling systems
- Eco-parks as strategy in Industrial ecology and local agenda 21 programmes
- Principles of good practise towards loop closing
- Development of information network system of Norwegian LCA databases
- Responsible companies in manufacturing industry

IndEcol Partners
In addition to the companies that are directly involved in the projects, there are several important contacts. International contacts to be mentioned are:

- Massachusetts Institute of Technology - Technology, Business & Technology Programme
- Yale University - Industrial Environmental Management Programme
- Georgia Tech - Centre for Sustainable Technology
- Delft Univ. of Technology - Industrial Design Programme; Systems Engineering & Policy Analysis
- Ecole des Mines de Paris - ISIGE

There is also a close contact to World Business Council for Sustainable Development: North Sea Region, and to Interreg (a co-operation between Norway and Sweden), to Cre-copernicus among others.

Future perspectives
The study programme is running fulltime this year with approximately 35 students. They say that *"The educational program is interesting, we have skilled professors, guest professors, and we feel that we are highly appreciated. The educational program is intimate and engaging, the education is bases on practical training in projects groups from different departments, and several specialists and guest professors are from industrial companies"*. A few criteria to measure the success of the IndEcol activities (both the study programme and P2005) are the number of publications, PhD-degrees, diploma thesis, seminars and conferences during a year. Over time it is also the intention to develop new multidisciplinary courses with an environmental contents for other students, or that students from traditional studies can participate in IndEcol-courses part time.

THE EUROPEAN PERSON EQUIVALENT: MEASURING THE PERSONAL ENVIRONMENTAL SPACE

Michael Hauschild and Henrik Wenzel
Department of Manufacturing Engineering and Management
Technical University of Denmark
Building 424, DK-2800 Lyngby
e-mail: mic@ipl.dtu.dk

The European person equivalent (PE) is a quantification of the environmental impact caused annually by the activities of an average European. It comprises contributions to all the major environmental impacts from global to local as well as our consumption of resources.

Similarly, the targeted European person equivalent (PET) is a quantification of the average person's environmental impact in a near future according to the current politically set environmental targets. In addition to expressing the current societal priorities in pollution reduction, the targeted PE expresses the environmental space available to all of us according to the current environmental policy.

Table 1 European PE and PET for a number of environmental impacts

Impact category	**UNIT**	**European PE** *(impact level per average European, 1994)*	**European PET** *(politically targeted impact level per average European, 2004)*
Global warming	g CO_2-eq/person/yr	$8.2 \cdot 10^6$	$7.9 \cdot 10^6$
Ozone depletion	g CFC11-eq/person/yr	0,081	0
Photochemical ozone formation	g C_2H_4-eq/person/yr	25	20
Acidification	g SO_2-eq/person/yr	74	49
Nutrient enrichment	g NO_3^--eq/person/yr	120.000	85.000
Chronic ecotoxicity in water	m^3 water/person/yr	350.000	290.000
Human toxicity via water	m^3 water/person/yr	52.000	35.000
Human toxicity via air	m^3 air/person/yr	$3.1 \cdot 10^9$	$2.9 \cdot 10^9$

While the PE is a measure of the current level of environmental impact from the European society's activities, the PET is a measure that on a per capita basis expresses the level that the European society aims to reduce its environmental impact to in the year 2004. The ratio between the PE and the PET is a measure of the ambitions of current environmental policy for each of the environmental problem areas. The more ambitious, the lower the PET. At the same time, the PET is a prediction of what the average impact per person (i.e. the PE) will be in the near future (provided that society pursues its environmental targets).

Both concepts were developed in the mid-nineties for use in life cycle impact assessment to help comparisons across different environmental impact categories (Wenzel et al., 1997, Hauschild and Wenzel, 1998). Since then they have shown their value as a pedagogic tool in the presentation and interpretation of environmental impacts from all kinds of man-made activities, technologies and systems.

An environmental assessment is performed of the possible introduction of technologies to treat the wastewater emission from a plant. The assessment results in the environmental profiles shown in Table 2 for the situation without and with treatment

Table 2. Environmental profile for plant (per year) before and after a proposed introduction of wastewater treatment.

Impact category	*Unit*	No treatment	Treatment
Global warming	kg CO_2-eq /yr	174.000	461.100
Ozone depletion	kg CFC11-eq/yr	0	0,808
Acidification	kg SO_2-eq/yr	868	2.480
Photochemical ozone formation	kg C_2H_4-eq/yr	200	720
Nutrient enrichment	kg NO_3^-eq/yr	3.576	5.364
Human toxicity	m^3 air/yr	$3{,}40 \cdot 10^{11}$	$1{,}38 \cdot 10^{11}$
Ecotoxicity	m^3 water/yr	$2{,}16 \cdot 10^{7}$	$9{,}60 \cdot 10^{6}$
Land use	ha·yr/yr	170	50
Volume waste	kg/yr	9.450	40.500
Hazardous waste	kg/yr	248	165

The example reveals a number of trade-offs between the two situations. The ecotoxicity and human toxicity caused by the emissions are strongly reduced by the treatment but the reduction is accompanied by a considerable increase in the energy-related impacts, global warming, acidification and photochemical ozone formation. So is it a good idea to treat the discharge from an environmental perspective?

No unambiguous answer can be given to the question but by expressing the environmental impacts in person equivalents they are expressed at a common scale and their relative size is displayed on the background from society's environmental overall environmental impacts as illustrated in Figure 1.

	A	B	
Global warming	174.000	461.100	kg CO_2-eq
Acidification	868	2.480	kg SO_2-eq
Photochemical ozone formation	200	720	kg C_2H_4-eq
Nutrient enrichment	3.576	5.364	kg NO_3^--eq
Human toxicity	$3{,}40.10^{11}$	$1{,}38.10^{11}$	m^3 air
Ecotoxicity	$2{,}16.10^{7}$	$9{,}60.10^{6}$	m^3 water
Land use	170	50	ha.yr
Volume waste	9.450	40.500	kg
Hazardous waste	248	165	kg

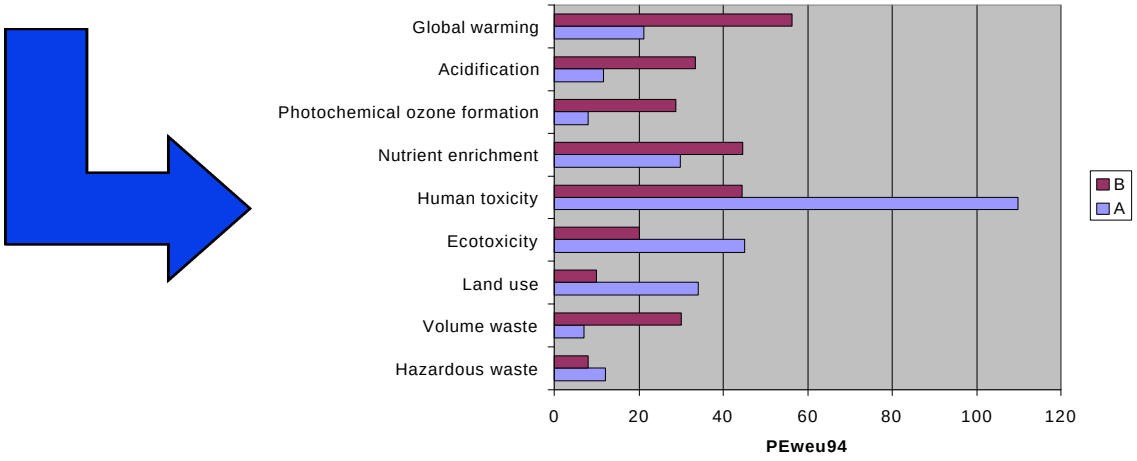


Figure 1. The environmental impacts are expressed in common units through translation into person equivalents, PE.

Expressing the impacts in PE's does enlighten the user on their relative sizes. It can be seen from Figure 1 that when compared to the societal background load, none of the impacts is completely insignificant compared to the others for either alternative. We are, however, still not able to answer the question whether we should treat the discharge or not. In order to do so, we must know how important the different impact categories are relative to each other. "Is global warming more important than acidification" and if it is, how much more important? In other words, we must have some values introduced into the comparison. Evidently, a valuation can not be objectively – we must decide whose values should be the basis for the final comparison.

When the impacts are expressed in targeted person equivalents, PET, instead of in PE's, the priorities of the current European environmental policy are introduced as values into the comparison. Now, an expression of the relative importance of the different impact categories has been introduced into the comparison. It is thus permissible to compare the impacts directly across impact categories when they are expressed as targeted person equivalents.

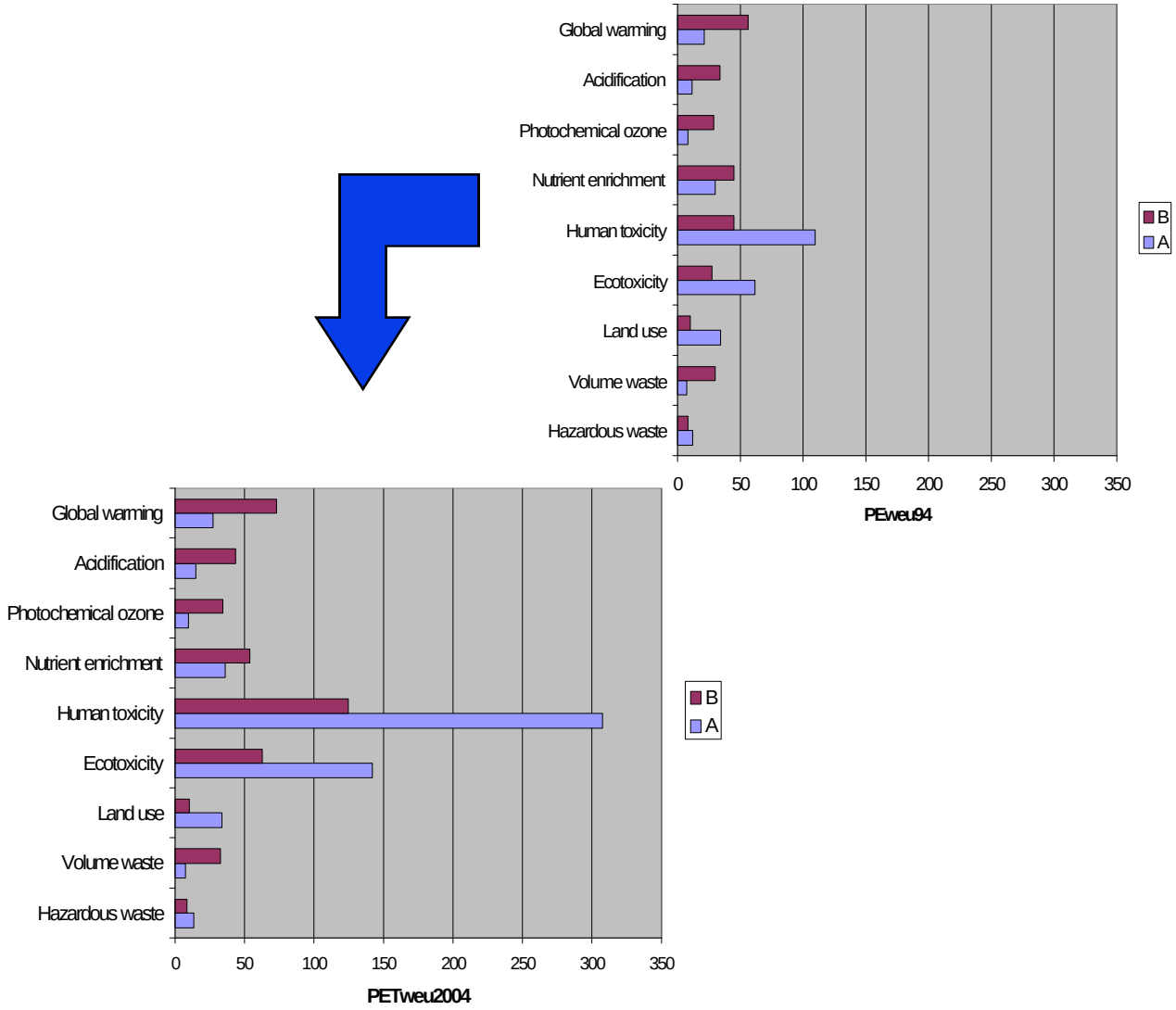


Figure 2. Introducing the priorities of current European environmental policy as values into the comparison by expressing the impacts in targeted person equivalents, PET

Accepting the current political reduction targets as a relevant expression of environmental importance, it can be concluded from Figure 2 that treatment should be preferred to non-treatment from an environmental perspective. Applying these values, the reductions in particularly ecotoxicity and human toxicity impacts are more important than the accompanying increases in the energy-related impacts.

The "environmental latitude" or “ecological space” is used to define the environmental impact that each person can cause in a sustainable society. In the same way, the PET is the "environmental policy target latitude" for the target year, i.e. the impact which we on average may cause for each of the impact categories if the targets for reductions are to be fulfilled.

The size of the environmental policy target latitude will gradually approach the size of the environmental latitude as the environmental policy targets approach the targets for sustainability. Table 3 shows a comparison between current political targets for 2004 and an approximate estimate of the needed reductions for sustainability.

Table 3 Current political reduction targets and sustainability reduction targets for a number of environmental impact categories

Impact category	Reduction for 2004 %	Reduction for sustainability %*
Global warming	4	65
Ozone depletion	100	<100
Photochemical ozone formation	20	50
Acidification	34	90
Nutrient enrichment	29	90
Chronic ecotoxicity in water	17	85

** highly approximative, sustainability targets ambiguous*

In conclusion, the targeted person equivalent has properties which makes it suitable as a yardstick for industry's environmental performance:

- It is centrally determined, indirectly derived from actual emission levels and current political reduction targets, and it is common to all
- It is reflecting society's priorities and the most probable development in environmental impacts
- It is providing an estimate of the personal environmental space in the near future
- It is suitable as a yardstick for industry's communication of environmental performance
- in green accounting
- in system and process optimisations
- in product documentation

References

Wenzel H, Hauschild M and Alting L (1997): Environmental Assessment of Products. Volume 1: Methodology, tools and case studies in product development. Kluwer Academic Publishers, second printing 2000, ISBN 0-412-80800-5 (hardbound), ISBN 0-7923-7859-8 (paperback).

Hauschild M and Wenzel H (1998): Environmental Asssessment of Products. Volume 2: Scientific Background Chapman & Hall 1998. Distributed by Kluwer Academic Publishers, ISBN 0 412 80810 2 (hardbound)

Associate professor Michael Hauschild from Department of Manufacturing Engineering, Technical University of Denmark explaining the European Person-Equivalent

INDUSTRIAL COMPANIES

DESIGN FOR ENVIRONMENT AT DANISH A/V PRODUCER BANG & OLUFSEN – CASE : COOL POWER, NEW AMPLIFIER TECHNOLOGY WITH 80-90% ENERGY REDUCTION

Jesper Olesen
Senior consultant, Bang & Olufsen a/s
Peter Bangs Vej 15, DK-7600 Struer
e-mail: jpo@bang-olufsen.dk
phone: +45 96 84 10 75, fax: +45 96 84 11 44

Abstract
The lecture focused on the following questions: Who is Bang & Olufsen and what is ”environmental concerns” at Bang & Olufsen ? What is the company’s Environmental focus ? How do Bang & Olufsen handle environmental issues during product development ?
Case: The ICE-power amplifier

ENVIRONMENTAL IMPACT ASSESSMENT (LCA) ENERGY AND RE-CYCLING FOR A CIRCULATOR

Nils Thorup, Senior Engineer
Grundfos A/S,
Research department,
DK-8850 Bjerringbro

Abstract
The use of LCA in the product development process points out two clear areas of improvement of the environmental impact of a Circulator. Most of the energy used in the whole life cycle, from cradle to grave, is used in the use phase of the circulator, with the end user of the product. Typically, 99% of the whole life cycle energy is consumed in this phase.

All other phases like raw material productions-, transport- and the disposal phase consume 1%. The main environmental improvement will therefore be development of highly efficient pumps, and secure the right dimensions of the pump to the system were in it has to operate.

An other important environmental improvement of the pumps environmental performance, is to make sure, that the resources, bound in the product, can be recycled on disposal. The most important material in a typical Circulator is the Copper. Therefore, the Circulator should be constructed in a way, that the copper can be recycled in the disposal stage.

The conclusion from the LCA of the circulator is valid for almost all types of pumps, which run daily during the use phase. Only "special" pumps like "pumps in fire fighting equipment" have a different environmental impact profile.

At Grundfos we use the Danish LCA-tool EDIP (Environmental Design of Industrial Products) to secure that the environmental performances are documented in the product development process.

PRODUCT ORIENTED ENVIRONMENTAL MEASURES AT VOLVO

Tomas Rydberg
Volvo Technological Development Corporation
Dept 6700, PVH 38
40508 Göteborg, Sweden
phone: +46 31 59 52 27
fax: +46 31 54 61 88
email: tu.tomasr@memo.volvo.se

Abstract
This presentation aims to show a variety of product oriented environmental measures that have been and are taken within Volvo Companies, including Cars, Trucks, Buses, Construction Equipment, Marine powertrains and Aerospace products. Some examples from the past up to now will be covered in the presentation, and also some aspects on present work which will contribute to reduced impact in the future, relating to for example:
- Fuel consumption

- Alternative fuels
- Alternative powertrains
- Lightweight materials
- Emissions
- Tools and working methods for environmental care in product development

Volvo (AB Volvo & Volvo Car) has been a forerunner and a major driving force in the development and use of Product oriented environmental measures in Swedish companies, especially from the late 1980's and onward. Volvo Car was also the first company to publish a third-party certified Environmental product declaration, in connection with the launch of the sedan S80 in may 1998. Volvo Technological Development Corporation is a corporate, task driven, R&D unit
operationally integrated in Volvo´s different business areas.

FACTOR 2 PROJECT ON TELECOMMUNICATION AT ERICSSON ENTERPRISE SYSTEMS AB

Lars Lenell, Ericsson Enterprise Systems AB
Ulf Östermark, Chalmers Industriteknik

An extensive Life Cycle Assessment project at the Enterprise Systems has been concluded during year 1999. About ten persons from Enterprise Systems have together with Flextronics International Inc. and Chalmers Industriteknik, collected a large amount of inventory data at a detailed level. Almost everything. Raw material extraction, component manufacturing, the product production at the Flextronics factory, the Ericsson “office parts” (design process, marketing, sales, distribution, service, installation and maintaining), the use stage and the end-of-life treatment were included in the study.

The purpose of the project was to create a ”base platform” for the future system design goals and work of the Private Branch Exchange MD110. The study resulted in concrete design guidelines, which are important to focus on in future product development, and has given a large material- and inventory database for the Business Unit.

A new (BC10) and an old (BC8) model of the private branch exchange MD 110, produced and sold by Ericsson Enterprise Systems, in this case for the EU market, has been compared. The Life Cycle Assessment (LCA) is a technique for assessing the environmental aspects and potential impact, associated with a product’s whole life cycle from the “cradle to the grave”.
This study meets the requirements of the international standards EN ISO 14040:1997 E, ISO 14041:1998 E and the draft standard ISO/DIS 14042 and 14043 from the International Organisation for Standardisation. A third party reviewer has also critically reviewed the study.

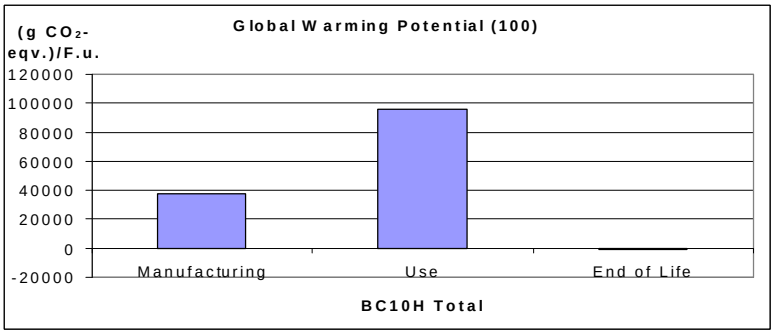
The modelling of the system includes manufacturing (hardware and Ericsson’s organisation), use stage (electricity consumption), end-of life (recycling processes) and transports. Electronic devices are modelled in depth (16 groups of components) and data from over 40 suppliers have been collected. Ericsson’s organisation (development, marketing&sales, supply, installation, service and sustaining) is modelled for use of offices and business travelling.

The comparison between the two generations of the system showed that the technical development towards reduced electricity consumption and more compact design resulted in a reduction of the environmental impacts.

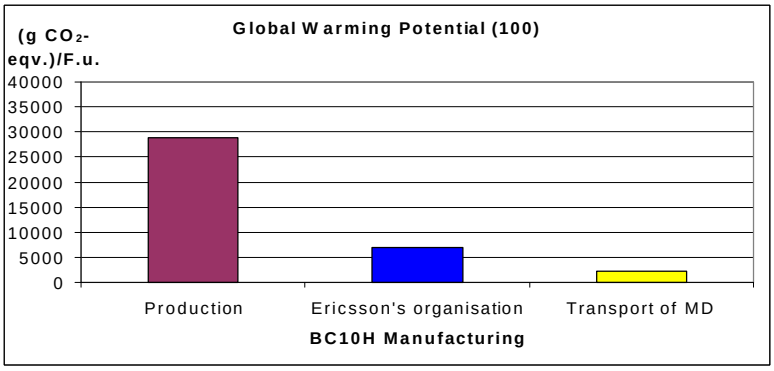
The following main conclusions of the project are based on results for potential contributions to the environmental impact categories acidification, global warming and eutrophication, which were chosen to be the most relevant. The results predominantly reflect energy use, whereas toxicological aspects needs separate attention (could not be reliably assessed due to lack of data and reliable methods). The technology improvements shown for BC10 compared to BC8 do only describe design improvements made by Ericsson, and does not take into account potential technology production improvements made by suppliers.

The following main conclusions are illustrated with results for global warming. The unit is grams of carbon dioxide equivalents per functional unit (one extension line during use in 15 years).

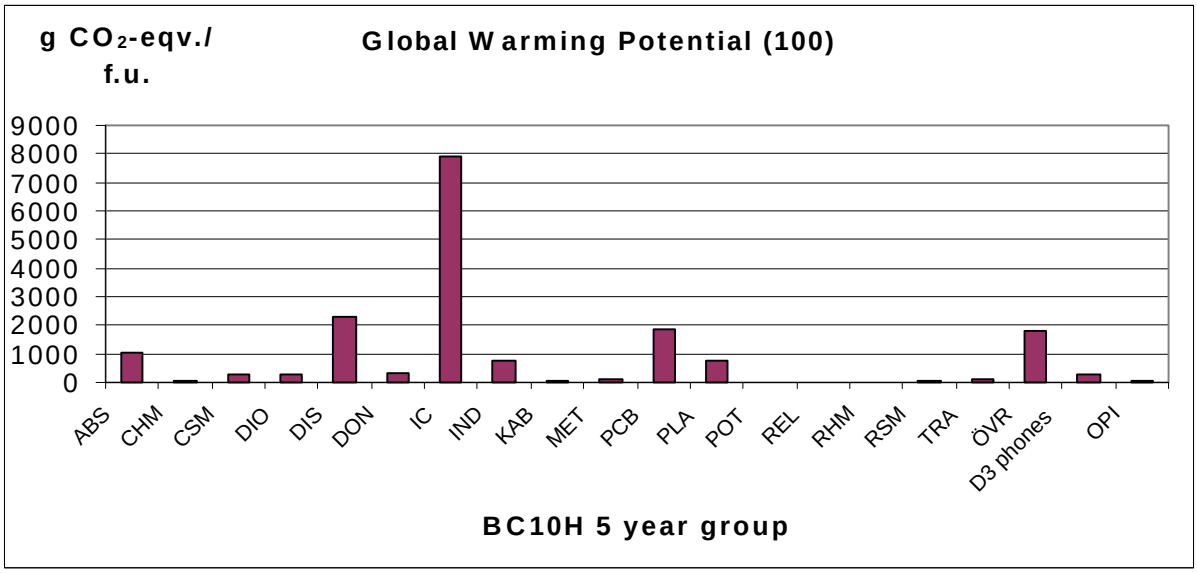
- As illustrated in the diagram below, the use stage and the manufacturing stage are the most important stages of the products' life cycle.
- The end-of-life stage appears to be of low or moderate importance for the energy-related impacts, but may be of large importance for toxicological impacts not reliably covered in this study.



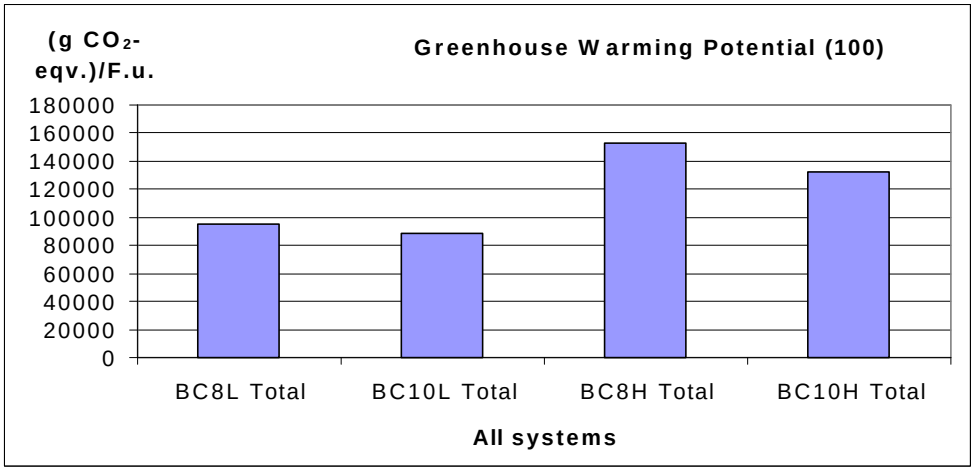
- In the manufacturing stage, the hardware production is dominating and Ericsson's organisation is secondly most important.



- Production of integrated circuits (IC) appears to be the individually most significant issue of the hardware production (approximately 20-40%). Printed circuit boards (PCB) contribute approximately 10% of the total score for hardware production.



- The environmental impact improvements of the new model compared to the old are approximately 10%, and the uncertainty of the results is judged to be smaller than the difference between the systems.



The conclusions lead to the following design guidelines:

- For existing MD 110 system, focus on decreasing the electricity consumption during the use stage.

- When possible, reduce the total area of silicon and the total size of capsules for ICs by substitution of standard ICs with application specific integrated circuits (ASICs).

- In future product development, the largest possibilities for the hardware appears to lie on a conceptual level (system design level). It appears to be difficult to reduce environmental impact significantly only by component substitution or detail construction adjustments.

- In future product development it is also recommended to include organisational development as a possibility for decreased environmental impact.

PRACTICAL EXPERIENCES IN THE FIELD OF PRODUCT-ORIENTED ENVIRONMENTAL MANAGEMENT IN THE TEXTILE INDUSTRY .

Leif Nørgaard , Novotex,
Green-Cotton,
Ellehammervej 6, 7430 Ikast , Denmark
ln@green-cotton.dk

Novotex , a traditional Danish garment maker began as early as 1986 to consider the environment as an important part of a garment. From the beginning very simple ideas – but despite this the first life-cycle assessment was mad as early as 1988.

Novotex began as one of the first companies in the world growing their own certified organic cotton (beg. in Turkey in 1988). We realized that Novotex is not a farm-company - and the idea costs a lot of money. When the first ideas about environmental management were introduced Novotex was again in front and introduced – supported by the Danish EPA – the BS 7750 . Later up-grated to EMAS and to ISO 14.001.

The strategy of ECO-labeling fitted Novotex well – and I was a member of the working group from the very beginning. To day the strategy of Novotex is to use ISO 14.001 (EMAS) on very product-level to prove the impact on the environment. By using the environmental management-system one can prove the fulfillment of the criteria in the eco-labeling - and thus integrating the two systems.

The VISION is to add working conditions to the requirements in ISO 14.001 (has happened) . Social responsibility is another important question which can be delt with by talking the rules of ILO and add those to the ISO 14.001.
Culture and commitment is necessary not to forget - but difficult to quantify

Where no ISO 14.001 is available - by some smaller suppliers – a questionnaire of ”Environmental impact assessment” is used. The above strategy – documentation - is used to prove the 4th marketing-tool : Environment

For 100 years three marketing tools only have been used in textile.
1. Price
2. Quality
3. Design - now adding the fourth
4. environment

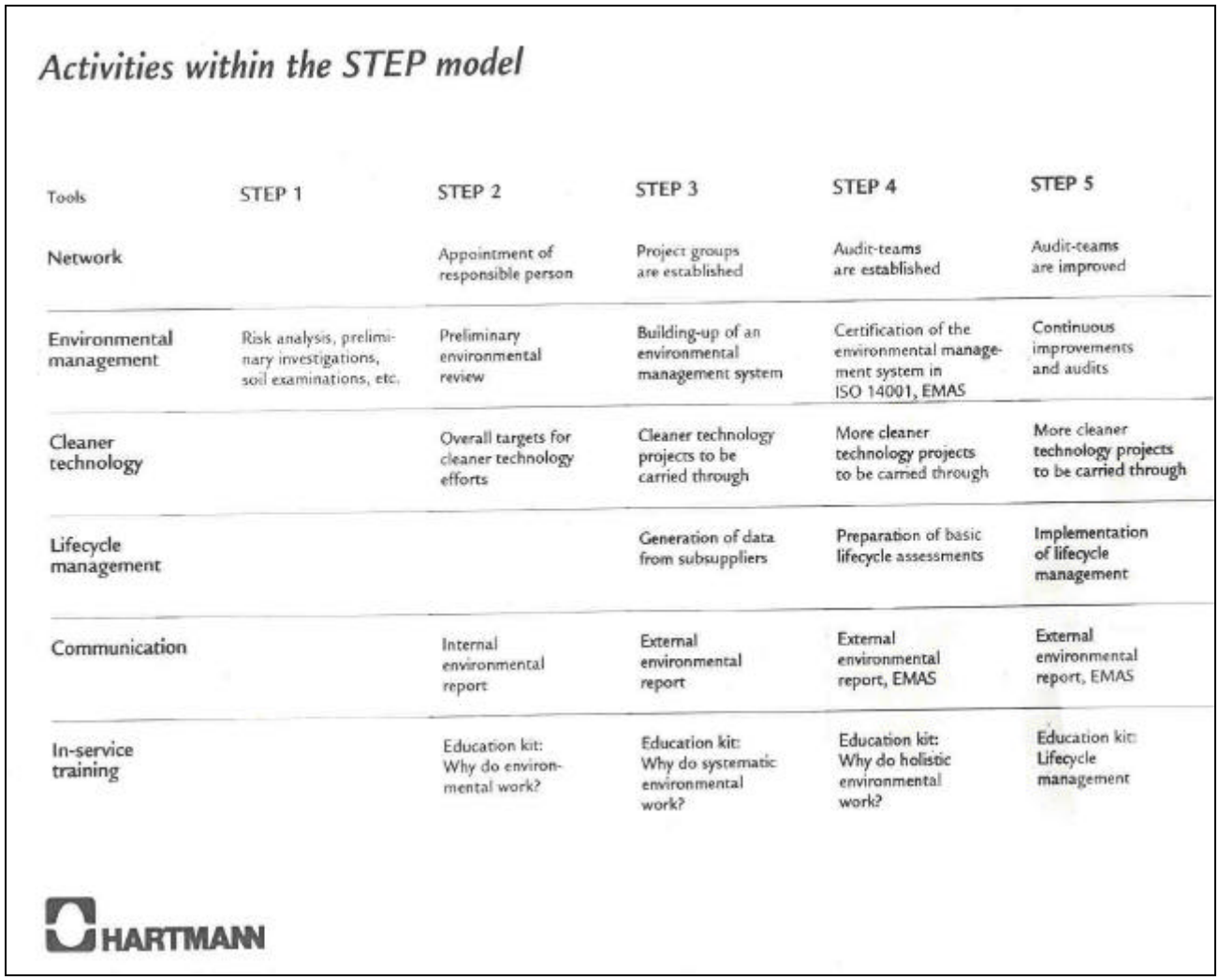
All build on existing tools. Just simple coordinated into a integrated approach for textiles.
The only problem: A strategy to inform the consumer, to convince the consumer, to educate the consumer.

THE STEP MODEL – THE ENVIRONMENTAL MANAGEMENT TOOL IN HARTMANN, INCLUDING LIFE CYCLE MANAGEMENT

Anna Lise Mortensen,
Corporate Environmental Manager at Hartmann A/S,
Klampenborgvej 203, DK-2800 Lyngby, +45 45 87 50 30,
environment@hartmann.dk.

Summary
Hartmann was founded in 1917 and has specialized in the production of moulded pulp packaging based on recycled paper. Hartmann has approx. 2000 employees. The products include egg and fruit packaging and also customized packaging for large industrial customers.

The STEP model describes the environmental demands put on the different production sites in the Hartmann Group. Or even before, since it is included in the work right from the initial considerations and examinations in connection with the acquisition of a new company. Hartmann developed the STEP-model in 1997. STEP stands for Systematic Tool for Environmental Progress and it is a all-in-one management model.



Activities within the STEP model

Tools	STEP 1	STEP 2	STEP 3	STEP 4	STEP 5
Network		Appointment of responsible person	Project groups are established	Audit-teams are established	Audit-teams are improved
Environmental management	Risk analysis, preliminary investigations, soil examinations, etc.	Preliminary environmental review	Building-up of an environmental management system	Certification of the environmental management system in ISO 14001, EMAS	Continuous improvements and audits
Cleaner technology		Overall targets for cleaner technology efforts	Cleaner technology projects to be carried through	More cleaner technology projects to be carried through	More cleaner technology projects to be carried through
Lifecycle management			Generation of data from subsuppliers	Preparation of basic lifecycle assessments	Implementation of lifecycle management
Communication		Internal environmental report	External environmental report	External environmental report, EMAS	External environmental report, EMAS
In-service training		Education kit: Why do environmental work?	Education kit: Why do systematic environmental work?	Education kit: Why do holistic environmental work?	Education kit: Lifecycle management

HARTMANN

Figure 1. the STEP-model

The STEP model operates with a horizontal development dimension (STEP 1-5, from basic to advanced) and a vertical tool dimension. The vertical tool dimension is built upon six environmental tools, which are all considered necessary in order to achieve a sustainable development: Network, environmental management, cleaner technology, lifecycle management, communication and in-service training

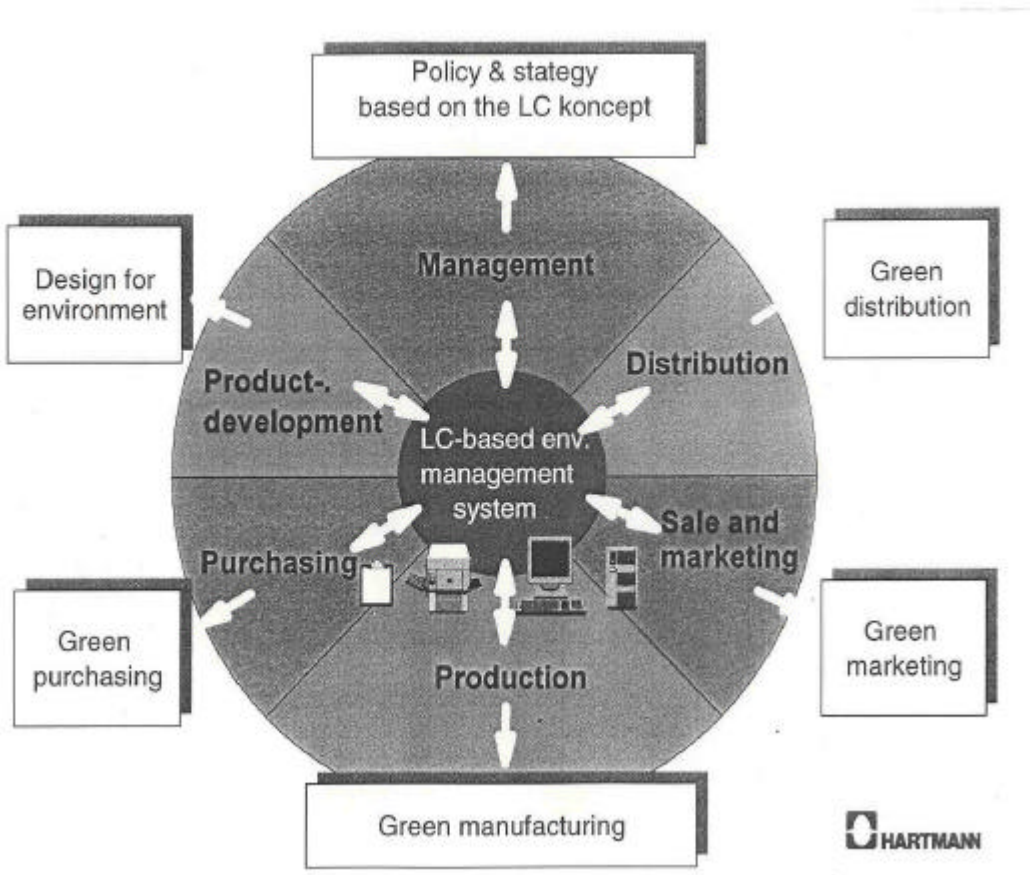


Figure 2. Life Cycle based environmental management system

The corporate environmental department has developed a number of implementation tools for the production sites. These tools range from report guidelines to advanced life cycle based management tools, which support and facilitate the implementation of the STEP model.

SPECIAL TOPIC DAY CONCLUSION

By Henrik Wenzel, Associate Professor, Technical University of Denmark, wenzel@ipl.dtu.dk

On this special topic day, we have learned about environmental achievements of a number of Nordic companies. Environmental improvement in the order of 50% in one step, and even more over a limited period of time, have been presented for us for products like pumps and egg trays. Yesterday, we learned that electronics' stand-by energy could be reduced by a factor of 10 or maybe even 20, and we met ICEpower®, the newly developed amplifier using only 10% of the energy of conventional amplifiers.

Environmental product improvements of this magnitude have come through in a very short time period of say 4-5 years. It is our experience from doing a large number of Life Cycle

Assessments and Eco-design initiatives of industrial products that very large improvement potentials exist for most products.

Products are produced to fulfil human needs. And human needs are increasing. With increasing population and increasing material standards of life, the need of products and services of human beings seem to increase by a factor of 5 or more over 50 years. The task is, thus, to increase the environmental- and resource efficiency of the way in which we fulfil these needs, i.e. to reduce the resource consumption and environmental impacts per service provided/need fulfilled. This task can be solved by measures on different level. Figure 1 illustrates these levels:

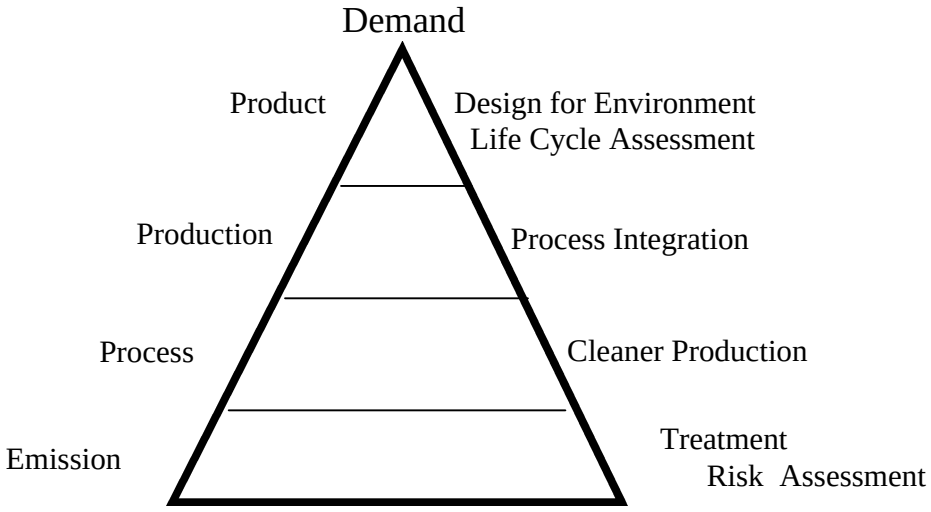


Figure 1. Levels of environmental improvement measures. A demand and supply chain

The figure shows a cause/effect chain – or one might say a demand/supply chain:

The human need is the demand of the product. If this need could be reduced, less products would be produced in the world. Unfortunately, it seems that this need will increase, as mentioned above.

The product is the supply fulfilling the need. At the same time, however, the product is the demand of the production. Productions throughout the world only take place, because they as part of a supply chain contribute to final end-user products fulfilling end-user needs somewhere. If the product were intelligently re-engineered/re-developed, using e.g. life cycle assessment and eco-design techniques, the demand for production volumes and/or hazardous production types might decrease. Cf. the development of a new amplifier implying a demand of electricity production of only 10% of the conventional amplifiers during use. A lot of effort goes into reducing environmental impacts from electricity production – like we have learned from Dr. Atimtay on Tuesday. Improvement measures on products will reduce the effort needed on productions.

The production is the supply providing the product through the supply chain. At the same time, however, it is the demand of the individual process. Processes in the company only take place, because they as part of the chain/network of processes at the production site contribute to the final output from the production. If the production were intelligently re-engineered/re-designed, using e.g. process integration techniques like the ones we learned of last year in Belfast, the demand for process volumes and/or hazardous processes might decrease. The Industrial Symbiosis in the city of Kalundborg, that we saw yesterday, is an example of process integration reducing the needed volume of the individual processes in the symbiotic industrial network. Improvement measures on productions will reduce the effort needed on the individual process.

The process is the supply providing the output from the production site through the chain/network of processes on the site. At the same time, however, the individual process is the demand for the resulting input from nature (resource consumption) and the cause of the final output to nature (emission). Inputs and outputs only take place, because they are the precondition of the process providing its service. If the process were intelligently re-engineered/re-designed, using cleaner production techniques, like we saw in electroplating two years ago in Cincinnati, the demand for resources and the emissions would decrease. And with it the need for treatment measures.

Measures are possible at all levels of this demand-supply chain, and very large improvement potentials exist at all levels. There are no overlaps between measures at the different levels and they truly supplement each other.

Working on one level without the other is a misunderstanding and will never be cost-effective. Why struggle and fight on the production level with reducing the negative impacts of electricity production if it were much more cost-effective to reduce the demand for electricity on the product level? Measures on the product level taken by Nordic companies have been presented on this special topic day. The product focus is, however, very new in environmental policy, and Nordic companies are among the world leaders. There are still many lessons to be learned still in this area, and still very large perspectives in working in it. RETURN TO CONTENTS PAGE